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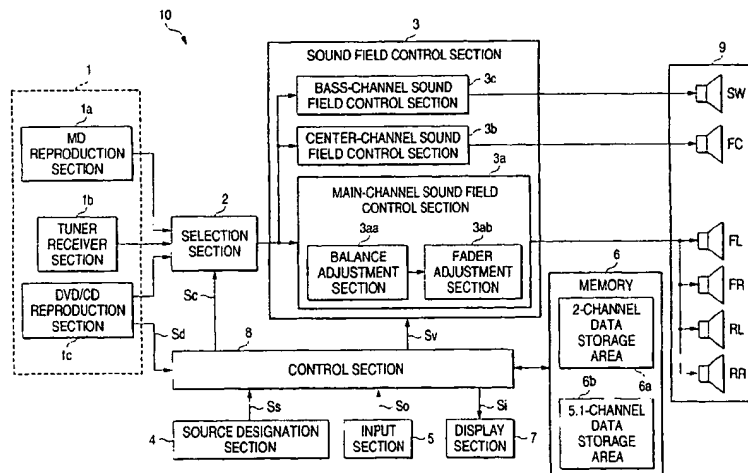
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(54) Audio apparatus

(57) An audio apparatus 10 which outputs audio signals from two front speakers FL and FR and a front center speaker FC that is placed between the front speakers FL and FR has: a balance adjustment section 3aa which adjusts the balance of the levels of the audio signals

output to the front speakers FL and FR; and a center-channel sound field control section 3b which adjusts the level of the audio signal output from the center speaker FC on the basis of a result of the balance adjustment by the balance adjustment section 3aa.

FIG. 1



[Fig. 2]

Fig. 2 is a diagram showing the arrangement of speakers in a cabin.

[Fig. 3]

Fig. 3 is a view showing the configuration of a balance/fader adjusting button.

[Fig. 4]

Fig. 4 is a view showing a display screen in the case of balance/fader adjustment.

[Fig. 5]

Figs. 5A to 5C are principle diagrams illustrating a fader adjustable range of a fader adjustment section.

[Fig. 6]

Fig. 6 is an operation flow diagram of a sound field control of an audio apparatus 10.

[0014] An audio apparatus 10 of an embodiment of the invention will be described with reference to the accompanying drawings. The invention will be described by means of an embodiment in which the invention is applied to the vehicle audio apparatus 10 that, in order to allow a multi-channel source for the 5.1-channel system or the like to be reproduced, comprises a center speaker FC placed in the center of a front side, and a woofer SW for bass enhancement in addition to front left and right speakers FL and FR and rear left and right speakers RL and RR.

[0015] First, the configuration and schematic operation of the audio apparatus 10 of the embodiment will be described with reference to Figs. 1 to 4. Fig. 1 is a diagram showing in principle the configuration of main portions of the audio apparatus 10 and the signal flow in the apparatus, Fig. 2 is a diagram showing the arrangement of speakers in a cabin, Fig. 3 is a view showing the configuration of a balance/fader adjusting button, and Fig. 4 is a view showing a display screen of a display section 7 in the case of balance/fader adjustment.

[0016] As shown in Fig. 1, the audio apparatus 10 of the embodiment includes: a reproduction section 1 having a plurality of audio sources; a selection section 2 which selects one of the audio sources of the reproduction section 1; a sound field control section 3 which controls the sound field of an audio signal of the audio source that is selected by the selection section 2; a speaker group 9 which outputs the sound field-controlled audio signal; a source designation section 4 which designates a source that is to be selected by the selection section 2; an input section 5 to which an adjustment value for controlling the sound field in the sound field control section 3 is input by the listener; a memory 6 which stores sound field control data for performing a sound field control by the sound field control section 3; the display section 7 which displays various kinds of information; and a control section 8 which controls the whole apparatus.

[0017] The reproduction section 1 has a plurality of audio sources such as an MD reproduction section 1a,

a tuner receiver section 1b, and a DVD/CD reproduction section 1c. Audio signal outputs from the audio sources are supplied to the selection section 2. The selection section 2 selects an audio signal corresponding to the audio source which is designated by a selection signal Sc supplied from the control section 8, and supplies the selected audio signal to the sound field control section 3 in the subsequent stage. The sound field control section 3 includes: a main-channel sound field control section 3a which controls the sound field of the audio signals output from the front left, front right, rear left, and rear right speakers; a center-channel sound field control section 3b which controls the sound field of the audio signal output from the center speaker FC; and a bass-channel sound field control section 3c which controls the sound field of the audio signal output from the woofer SW, and performs a sound field control on the audio signals on the basis of a sound field control data Sv supplied from the control section 8. The main-channel sound field control section 3a has a balance adjustment section 3aa and a fader adjustment section 3ab each of which is configured by an electronic volume controller.

[0018] As shown in Fig. 2, the speaker group 9 is configured by the front left and right speakers FL and FR, the rear left and right speakers RL and RR, the front center speaker FC, and the woofer SW. In accordance with the number of channels of the selected audio signal, the audio signal is supplied to the speakers. Specifically, in the speaker group 9, when a 2-channel source is selected, an audio signal is supplied to the left and right speakers of the front and rear sides, and, when a 5.1-channel source is selected, an audio signal is supplied to the center speaker FC and the woofer SW in addition to the left and right speakers of the front and rear sides.

[0019] The source designation section 4 is means for designating a desired audio source by the listener, and supplies information relating to the audio source designated by the listener, as a designation signal Ss to the control section 8. In response to the designation signal Ss, the control section 8 produces the selection signal Sc on the basis of the designation signal Ss, to instruct the selection section 2 to switch over the audio source. The input section 5 is means for inputting an adjustment value for performing a sound field control on the audio signal designated by the source designation section 4, and has at least a balance/fader adjusting button 5a which is formed into a cross shape shown in Fig. 3, and an input button (not shown) for adjusting the volume of the woofer SW. When one of the buttons is operated by the listener, the input section 5 supplies to the control section 8 an adjustment data So according to the degree of the operation imposed on the button. On the basis of the received adjustment data So, the control section 8 produces the sound field control data Sv to instruct the sound field control section 3 to perform a sound field control on the audio source. The memory 6 has: a 2-channel data storage area 6a in which the sound field

range from -10 dB in the front side to -10 dB in the rear side or reduces the variable attenuation amount, so that the adjustment in the vicinity of 0 dB can be finely performed.

[0029] This switching of the adjustable range is conducted in view of the fact that the audio signal is produced on the premise that, in a 5.1-channel source, the reproduction volumes of the channels are equal to one another at the listening position. Namely, the adjustable range of a 5.1-channel source is not required to be widened to a range where the volume difference among the channels is extremely large. From the viewpoint of the listener, a wider adjustable range causes the attenuation amount per step to be increased, with the result that fader adjustment is roughly performed. By contrast, in the case of a narrow adjustable range, the attenuation amount per step can be set to be small, and hence fine fader adjustment can be performed so that the volume difference in the anteroposterior direction is constant.

[0030] Fig. 5B shows the case of a 2-channel source in which one step corresponds to -10 dB so that the attenuation amount at the tenth step is $-\infty$, and Fig. 5C shows the case of a multi-channel source in which attenuation of -1 dB is attained by one step so that the attenuation amount at the tenth step is -10 dB. According to the configuration, in the case of a 2-channel source, the listener can select desired localization from the wide adjustable range, and, in the case of a 5.1-channel source, can select optimum localization from the narrow adjustable range in an easier manner.

[0031] Next, volume adjustment of the center speaker FC will be described.

[0032] The apparatus is configured so as to automatically calculate the value of volume adjustment of the center speaker FC from a balance/fader adjustment value. As shown in Fig. 2, the center speaker FC is basically placed between the front left and right speakers. Therefore, the volume adjustment value can be virtually calculated by using the balance/fader adjustment value of the front left and right speakers. Since the center speaker FC is placed in the front side in the same manner as the front left and right speakers, at least an attenuation value which is equivalent to the fader adjustment value of the front left and right speakers is necessary. Since the center speaker FC is placed between the front left and right speakers, the attenuation value between the balance adjustment value of the front left speaker and that of the front right speaker is required in accordance with the placement position of the center speaker. A specific calculation method will be described with reference to Fig. 4.

[0033] First, the center-channel sound field control section 3b reads from the sound field control data Sv the balance/fader adjustment value of the front left and right speakers, and then obtains the attenuation amount of each of the front left and right speakers. Specifically, when the center-channel sound field control section 3b reads from the balance/fader adjustment value that the

right side is attenuated by -6 dB and the front side is attenuated by -2 dB, the control section obtains that the attenuation amount of the front left speaker is -2 dB and that of the front right speaker is -8 dB. Since the center speaker FC is placed at the median point of the front left and right speakers, the center-channel sound field control section 3b allocates the median value of the attenuation amount of the front left speaker and that of the front right speaker, as the volume of the center speaker FC. Namely, the center-channel sound field control section 3b allocates -5 dB which is the median value of -8 dB and -2 dB, as the volume of the center speaker.

[0034] In the audio apparatus 10, the center-channel sound field control section 3b performs the control in which the median value of the attenuation amounts of the front left and right speakers is allocated as the volume adjustment value of the center speaker. In the case where the center speaker FC is not placed at the median point of the front left and right speakers, the control may be performed in a different manner. Namely, the center-channel sound field control section 3b may be configured so that, in the case where the center speaker FC is placed with being deviated from the median point of the front left and right speakers, the attenuation amount is corrected in accordance with the degree of the deviation from the median point. When the center speaker FC is placed at a position where the gap between the front left and right speakers is divided at a ratio of 1 : 2, for example, the center-channel sound field control section 3b may set an attenuation amount which is obtained by dividing the relative attenuation amount of the front left and right speakers at the ratio of 1 : 2, as the attenuation amount of the center speaker.

[0035] The control section 8 may recognize the positional relationship between the front left and right speakers and the center speaker FC, from a preset value, or alternatively on the basis of information which is input by the listener.

[0036] The volume level of the woofer SW is independently adjusted by an adjusting button which is separately disposed, and which is not shown.

[0037] Next, the whole operation of the sound field control by the audio apparatus 10 will be described with reference to the operation flow shown in Fig. 6. Fig. 6 shows an operation program which is previously recorded in a ROM (not shown), and which is automatically executed in response to designation of a source by the listener, for example, selection of the DVD/CD reproduction section 1c.

[0038] When one of the audio sources is selected by the listener through the source designation section 4, the control section 8 of the audio apparatus 10 is transferred to step S1. In step S1, the control section 8 judges whether the selected audio source is a 5.1-channel audio source or not. In the case where the DVD/CD reproduction section 1c is selected and it is judged from the content information Sd supplied from the DVD/CD reproduction section 1c that the selected audio source is

transferred to step S5.

[0047] When the audio apparatus 10 is set to the adjustment mode, the speakers sequentially output an adjustment signal (such as pink noise), thereby allowing the listener to perform adjustment so that the volumes of the speakers are equal to one another at the listening position.

[0048] As described above, the audio apparatus 10 of the invention is previously provided with the memories for storing 2-channel sound field control data, and for storing multi-channel sound field control data which are independent from each other. Therefore, it is not required to reset the sound field setting in accordance with the audio channels to be reproduced. According to the audio apparatus 10 of the invention, in both the cases of a 2-channel source and a multi-channel source, the listener can perform balance/fader adjustment by using the inputting means and the display screen which are shared in both the cases. Therefore, the operation of balance/fader adjustment can be simplified. Depending on the kind of the source, or the case of a 2-channel source or that of a multi-channel source, moreover, the adjustable range of balance/fader is switched over. Consequently, the apparatus is configured so that the listener can easily adjust the sound field so as to be suitable to the contents. In the audio apparatus 10 of the invention, since the volume of the center speaker is adjusted on the basis of the balance/fader adjustment value, it is not necessary to additionally dispose means for inputting the volume adjustment value of the center speaker, and the process of setting the sound field in the case of a multi-channel source can be simplified.

[0049] In the above, the audio apparatus 10 of the embodiment has been described in which data relating to volume setting values of the speakers which define sound localization are stored in the memory 6 for each of the numbers of channels of audio sources. Alternatively, an adjustment value of a graphic equalizer may be stored in the memory 6 for each of the numbers of channels of audio sources. According to the configuration, when a 2-channel source is selected, the tone is automatically set to a favorite one, and, when a 5.1-channel source is selected, the apparatus is automatically set so that the tones of the speakers are equal to one another.

[0050] In the above, the audio apparatus 10 of the embodiment in which an audio signal of the 2-channel system and that of the 5.1-channel system are used has been described. The kinds of the audio signals are requested to those of the 2-channel system and a multi-channel system, and the multi-channel system is not restricted to the 5.1-channel system. The example in which a 5.1-channel audio signal is supplied from the DVD/CD reproduction section 1c has been described. Alternatively, an audio signal may be supplied from another audio source such as the tuner receiver section 1b. In the above, the audio apparatus 10 has been described in which the 2-channel system or the 5.1-channel

system is detected from the content information supplied from the DVD/CD reproduction section 1c when a multi-channel compatible DVD disk is to be subjected to a reproducing process. The manner of the detection is not restricted to this. The detection may be performed by counting the number of channels. The audio apparatus 10 described above is a vehicle audio apparatus. The kind of the apparatus is not restricted to this.

[0051] According to the invention, the sound field of a center speaker is set on the basis of a sound field setting value of front speakers, and therefore the process of setting the sound field of a multi-channel source can be simplified.

Claims

1. An audio apparatus which outputs audio signals from two front speakers and a center speaker that is placed between said front speakers, comprising:
 - a balance adjustment section which adjusts a balance of levels of the audio signals output from said front speakers; and
 - a center adjustment section which adjusts a level of the audio signal output from said center speaker on the basis of a result of the balance adjustment by said balance adjustment section.
2. The audio apparatus according to claim 1, wherein said center adjustment section recognizes positional relationships of said center speaker with respect to said front speakers, and adjusts the level of the audio signal output from said center speaker on the basis of a result of the recognition and the result of the balance adjustment by said balance adjustment section.
3. The audio apparatus according to claim 1, wherein an audio signal of a 2-channel system and an audio signal of a multi-channel system are used.
4. The audio apparatus according to claim 1, wherein the audio signal is supplied from a tuner receiver section.
5. The audio apparatus according to claim 1, wherein the detection is performed by counting the number of channels.
6. The audio apparatus according to claim 1 is provided on a vehicle.

FIG. 2

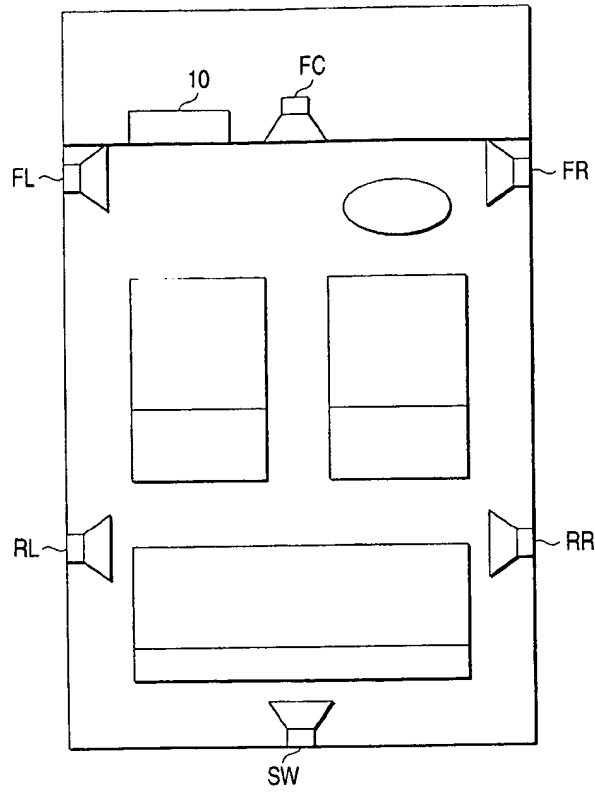


FIG. 3

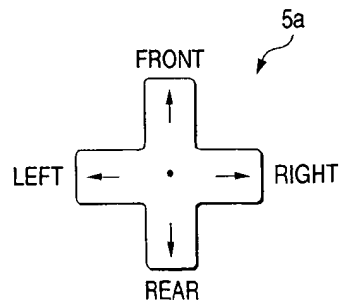
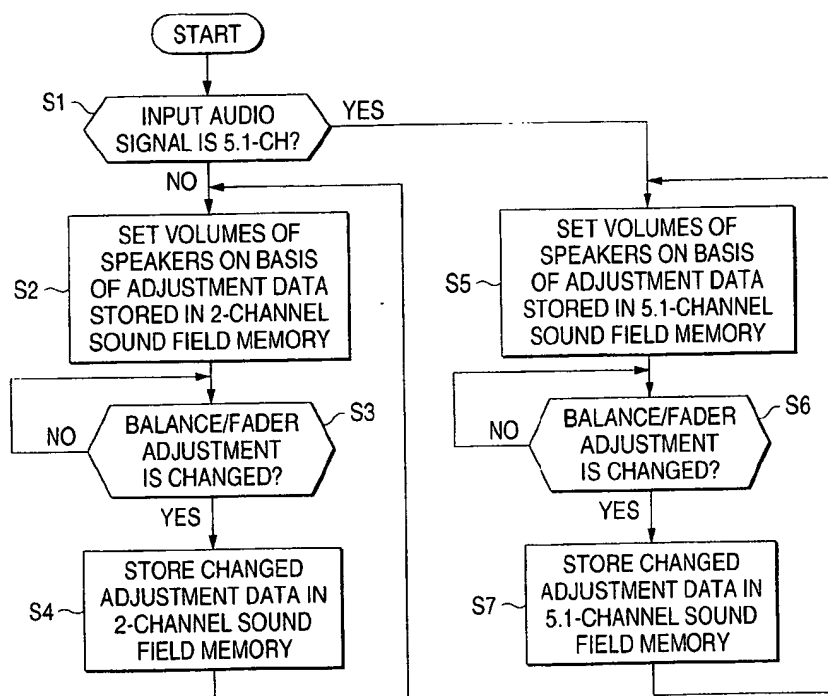
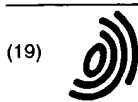


FIG. 6





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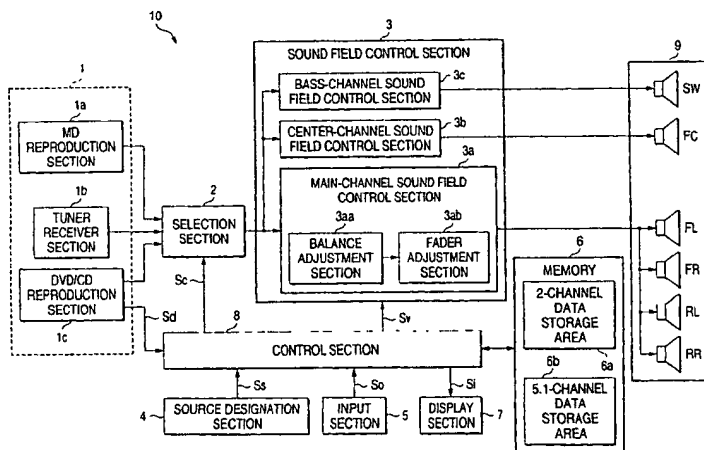
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output to the front speakers FL and FR; and a center-channel sound field control section 3b which adjusts the level of the audio signal output from the center speaker FC on the basis of a result of the balance adjustment by the balance adjustment section 3aa.

FIG. 1



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ANNEX TO THE EUROPEAN SEARCH REPORT
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